Laser Physics 2011 vol.21 N8, pages 1503-1510

Solid state multi-ensemble quantum computer in cavity quantum electrodynamics model

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Abstract

The first realization of solid state quantum computer was demonstrated recently by using artificial atoms - transmons in superconducting resonator. Here, we propose a novel quantum computer based on quantum electrodynamic cavity coupling many quantum nodes of controlled atomic ensembles. The quantum computer contains quantum memory and processing nodes. For the first time, we find the optimal practically attainable parameters of the atoms and optical scheme of the computer for realization of the multimode quantum memory for the photonic qubits with efficiency close to 100%. Then we reveal self modes for reversible transfer of the qubits between the quantum memory node and the processing nodes. Also, we find a realization of iSWAP gate via direct coupling of two processing nodes with an operation rate accelerated proportionally to the number of atoms in the nodes. Collective dynamic and static blockade mechanisms are proposed for realization of $\sqrt {iSWAP} $ quantum gate in multi atomic ensembles. A large number of the two-qubit gates can be simultaneously realized that opens a possibility for parallel quantum processing in the proposed quantum computer. © 2011 Pleiades Publishing, Ltd.

http://dx.doi.org/10.1134/S1054660X11150175